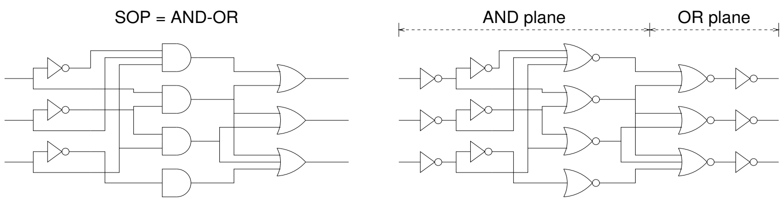
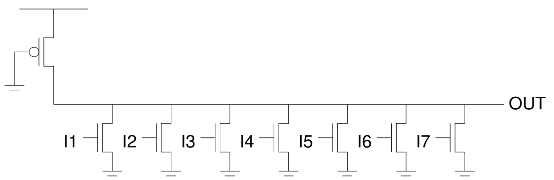
Sum Of Products

Programmable Logic Array structures provide a logical and compact method of implementing multiple SOP (Sum of Products) or POS expressions.



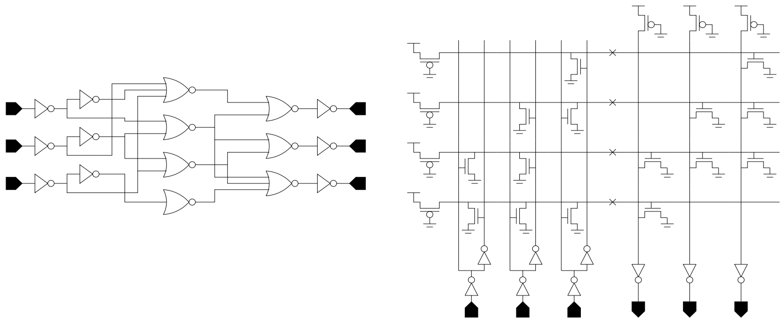
Most PLA structures employ pseudo-NMOS NOR gates using a P-channel device in place of the NMOS depletion load.

Pseudo-NMOS NOR gate



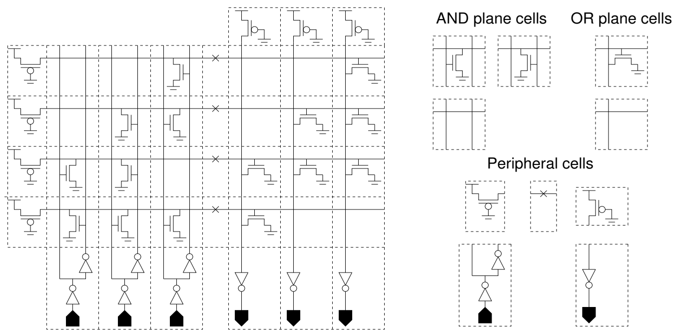
- Unlike complementary CMOS circuits, these gates will dissipate power under static conditions (since the P device is always on).
- The P and N channel devices must be ratioed in order to create the required low output voltage.
- This ratioing results in a slower gate, although there is a trade-off between gate speed and static power dissipation.

PLA structure



- A regular layout is employed, with columns for inputs and outputs and rows for intermediate expressions.

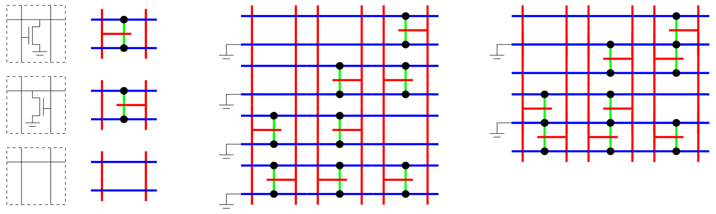
PLA structure



- Layout is simply a matter of selecting and placing rectangular cells from a limited set.

PLA

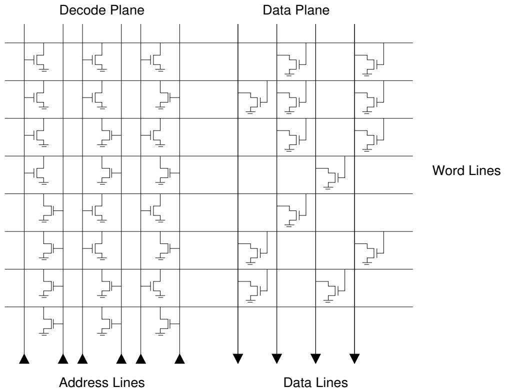
PLA structure



- Conversion to *sticks* is straight forward with opportunities for further optimization.

ROM

- A ROM may simply be a PLA with fixed decoder plane[1] and programmable data plane.

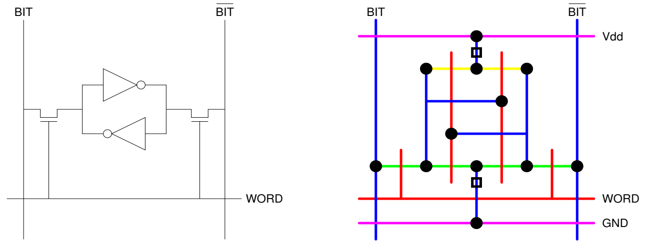


[1]RAM structures can make use of the same decode plane.

SRAM

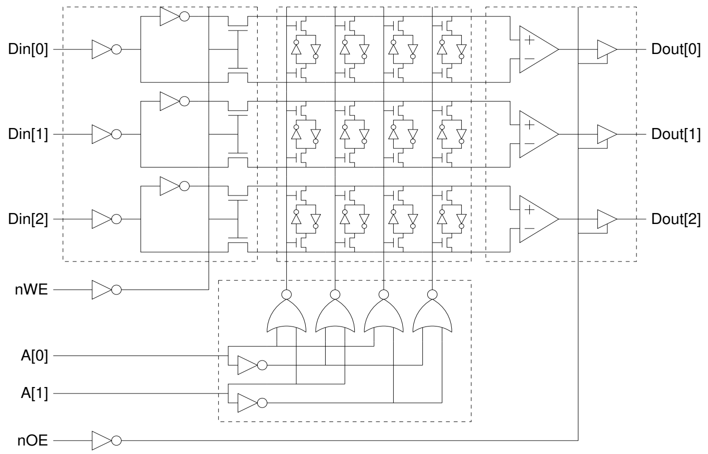
Static RAM Cell

- Short lived conflict during write - NMOS transistors offer stronger path.
- Differential amplifiers are used for speedy read.

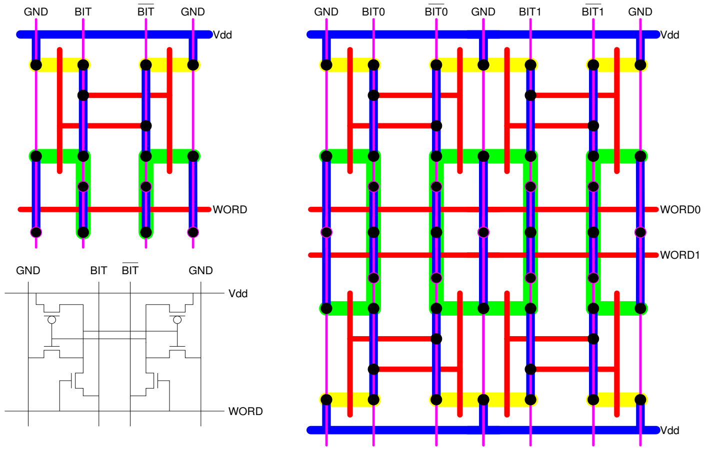


Standard 6 transistor static RAM cell.

SRAM Structure



SRAM

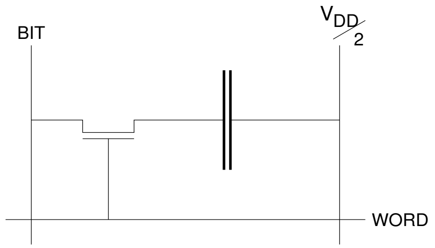


Alternative SRAM layout allows for better butting in two dimensions.

DRAM

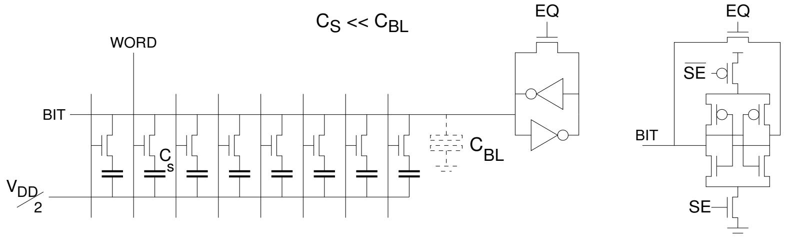
Dynamic RAM Cell

- Needs to be regulary refreshed (within ≈ 10-100 ms).
  - Each access performs a read then write refresh cycle.
- Higher density and slower access than SRAM.
  - High density requires a dedicated process to create suitably small high value (≈ 10-100 fF) capacitors.



DRAM

Dynamic RAM Read



- Precharge Bit line to Vdd/2 (SE=1 EQ=1)
- De-activate sense amplifier inverters (SE=0 EQ=0)
- Enable word line – Bit line voltage will change only slightly
- Activate sense amplifier – Positive feedback restores data (SE=1 EQ=0)